

WHAT IS CLAIMED IS:

1. A demodulator comprising:

a multiple differential phase detected signal output unit which calculates phase differences between a received signal and received signals of 1, 2, ..., N (where N is an integer greater than 2) symbols before so as to output the calculated results as 1, 2, ..., N symbol differential phase detected signals; and

a soft decision demodulated data estimating unit which estimates a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and Viterbi algorithm, and estimates soft decision demodulated data according to the estimated transmitted differential phase sequence and survival path metric that transit into each state on the trellis diagram.

2. The demodulator according to claim 1, characterized in that in said soft decision demodulated data estimating unit,

a bit corresponding to the differential phase composing a state having minimum/maximum survival path metric on the trellis diagram is hard decision data,

a difference between a survival path metric that transit into a state having minimum/maximum survival path metric and

one that transit into another state which has minimum/maximum survival path metric in the states composed the differential phase corresponding to the bits obtained by inverting the hard decision data are used as components is reliability information

5 of the hard decision data;

the soft decision demodulated data are generated according to the hard decision data and the reliability information.

10 3. A demodulator comprising:

a multiple differential phase detected signal output unit which calculates phase differences between a received signal and received signals of 1, 2, ..., N (Where N is an integer greater than 2) symbols before so as to output the calculated

15 results as 1, 2, ..., N symbol differential phase detected signals;

a power detection unit which detects power of the received signal; and

a soft decision demodulated data estimating unit which

20 estimates transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and Viterbi algorithm, and estimates soft decision demodulated data

25 according to the estimated transmitted differential phase

sequence, survival path metric that transit into each state on the trellis diagram and the power.

4. The demodulator according to claim 3, wherein in said soft decision demodulated data estimating unit,

5 a bit corresponding to the differential phase composing a state having minimum/maximum survival path metric on the trellis diagram is hard decision data,

a difference between a survival path metric that transit into a state having minimum/maximum survival path metric and

10 one that transit into another state which has minimum/maximum survival path metric in the states composed the differential phase corresponding to the bits obtained by inverting the hard decision data are used as components is multiplied by power so that the multiplied result is reliability information of  
15 the hard decision data,

the soft decision demodulated data are generated according to the hard decision data and the reliability information.

20 5. A demodulator comprising:

a multiple differential phase detected signal output unit which calculates phase differences between a received signal and received signals of 1, 2, ..., N (Where N is an integer greater than 2) symbols before so as to output the calculated  
25 results as 1, 2, ..., N symbol differential phase detected

signals;

a power detection unit which detects power of the received signal;

a  $\rho$ -multiplying unit which multiplies the detected power  
5 by  $\rho$ ; and

a soft decision demodulated data estimating unit which estimates transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of  
10 differential phase states of transmitted signals and Viterbi algorithm, and estimates soft decision demodulated data according to the estimated transmitted differential phase sequence, survival path metric that transit into each state on the trellis diagram and the  $\rho$ -multiplied value of the power.

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6. The demodulator according to claim 5, wherein in said soft decision demodulated data estimating unit,

a bit corresponding to the differential phase composing a state having minimum/maximum survival path metric on the  
20 trellis diagram is hard decision data,

a difference between a survival path metric that transit into a state having minimum/maximum survival path metric and the one that transit into another state which has minimum/maximum survival path metric in the states composed  
25 the differential phase corresponding to the bits obtained by

inverting the hard decision data are used as components is multiplied by the  $p$ -multiplied value of the power so that the multiplied result is reliability information of the hard decision data,

5           the soft decision demodulated data are generated according to the hard decision data and the reliability information.

7.       A receiver which receives data from a transmitter, said  
10   receiver comprising:

          a multiple differential phase detected signal output unit which calculates phase differences between a received signal and received signals of 1, 2, ..., N (Where N is an integer greater than 2) symbols before so as to output the calculated  
15   results as 1, 2, ..., N symbol differential phase detected signals;

          a soft decision demodulated data estimating unit which estimates a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals  
20   using a trellis diagram representing transitions of differential phase states of transmitted signals and Viterbi algorithm, and estimates soft decision demodulated data according to the estimated transmitted differential phase sequence and survival path metric that transit into each state  
25   on the trellis diagram; and

a decoding unit which decodes the original transmitted data based on the soft decision demodulated data.

5 8. A receiver which receives data from a transmitter, said receiver comprising:

a multiple differential phase detected signal output unit which calculates phase differences between a received signal and received signals of 1, 2, ..., N (Where N is an integer  
10 greater than 2) symbols before so as to output the calculated results as 1, 2, ..., N symbol differential phase detected signals;

a soft decision demodulated data estimating unit which estimates a transmitted differential phase sequence according  
15 to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and Viterbi algorithm, and estimates soft decision demodulated data according to the estimated transmitted differential phase  
20 sequence and survival path metric that transit into each state on the trellis diagram; and

an interleaving unit which interleaves the soft decision demodulated data according to a predetermined algorithm; and

a decoding unit which decodes the original transmitted  
25 data based on the soft decision demodulated data after the

interleaving.

9. A receiver which receives data from a transmitter, said receiver comprising:

5 a multiple differential phase detected signal output unit which calculates phase differences between a received signal and received signals of 1, 2, ..., N (Where N is an integer greater than 2) symbols before so as to output the calculated results as 1, 2, ..., N symbol differential phase detected

10 signals;

a power detection unit which detects power of the received signal;

a soft decision demodulated data estimating unit which estimates transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals  
15 using a trellis diagram representing transitions of differential phase states of transmitted signals and Viterbi algorithm, and estimates soft decision demodulated data according to the estimated transmitted differential phase  
20 sequence, survival path metric that transit into each state on the trellis diagram and the power; and

a decoding unit which decodes the original transmitted data based on the soft decision demodulated data.

25 10. A receiver which receives data from a transmitter, said

receiver comprising:

a multiple differential phase detected signal output unit which calculates phase differences between a received signal and received signals of 1, 2, ..., N (Where N is an integer greater than 2) symbols before so as to output the calculated results as 1, 2, ..., N symbol differential phase detected signals;

a power detection unit which detects power of the received signal;

10 a soft decision demodulated data estimating unit which estimates transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and Viterbi algorithm, and estimates soft decision demodulated data 15 according to the estimated transmitted differential phase sequence, survival path metric that transit into each state on the trellis diagram and the power; and

an interleaving unit which interleaves the soft decision demodulated data according to a predetermined algorithm; and

a decoding unit which decodes the original transmitted data based on the soft decision demodulated data after the interleaving.

25 11. A receiver which receives data from a transmitter, said



receiver comprising:

a multiple differential phase detected signal output unit which calculates phase differences between a received signal and received signals of 1, 2, ..., N (Where N is an integer  
5 greater than 2) symbols before so as to output the calculated results as 1, 2, ..., N symbol differential phase detected signals;

a power detection unit which detects power of the received signal;

10 a  $\rho$ -multiplying unit which multiplies the power by  $\rho$ ;

a soft decision demodulated data estimating unit which estimates transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of  
15 differential phase states of transmitted signals and Viterbi algorithm, and estimates soft decision demodulated data according to the estimated transmitted differential phase sequence, survival path metric that transit into each state on the trellis diagram and the  $\rho$ -multiplied value of the power;  
20 and

a decoding unit which decodes the original transmitted data based on the soft decision demodulated data.

12. A receiver which receives data from a transmitter, said  
25 receiver comprising:

a multiple differential phase detected signal output unit which calculates phase differences between a received signal and received signals of 1, 2, ..., N (Where N is an integer greater than 2) symbols before so as to output the calculated results as 1, 2, ..., N symbol differential phase detected signals;

a power detection unit which detects a power of the received signal;

a  $\rho$ -multiplying unit which multiplies the power by  $\rho$ ;

10 a soft decision demodulated data estimating unit which estimates transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and Viterbi

15 algorithm, and estimates soft decision demodulated data according to the estimated transmitted differential phase sequence, survival path metric that transit into each state on the trellis diagram and the  $\rho$ -multiplied value of the power; and

20 an interleaving unit which interleaves the soft decision demodulated data according to a predetermined algorithm; and

a decoding unit which decodes the original transmitted data based on the soft decision demodulated data after the interleaving.

13. A communication system comprising a transmitter for transmitting a data and a receiver for receiving the data, wherein

said transmitter having,

5 a convolutional coding unit which convolutional encodes the transmitted data;

a converting unit which converts the convolutional-coded data into a transmission differential phase;

10 a differential coding unit which differential encodes the transmission differential phase and maps the differential encoded data to the signal phases; and

a transmission signal generation/output unit which generates/outputs a differential phase modulated signal based on the transmission signal phase,

15 said receiver having,

a multiple differential phase detection signal output unit which calculates phase differences between a received signal and received signals of 1, 2, ..., N (Where N is an integer greater than 2) symbols before so as to output the calculated  
20 results as 1, 2, ..., N symbol differential phase detected signals;

a soft decision demodulated data estimating unit which estimates a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals  
25 using a trellis diagram representing transitions of

differential phase states of transmitted signals and Viterbi algorithm, and estimates soft decision demodulated data according to the estimated transmitted differential phase sequence and survival path metric that transit into each state

5 on the trellis diagram; and

a decoding unit which decodes the original transmitted data based on the soft decision demodulated data.

10 14. A communication system comprising a transmitter for transmitting a data and a receiver for receiving the data, wherein

said transmitter having,

15 a convolutional coding unit which convolutional encodes the transmitted of the data;

a first interleaving unit which interleaves an order of the convolutional-coded data according to a predetermined algorithm;

20 a converting unit which converts the interleaved data into a transmission differential phase;

a differential coding unit which differential encodes the transmission differential phase and maps the differential encoded data to the signal phases; and

25 a transmission signal generation/output unit which generates/outputs a differential phase modulated signal based

on the transmission signal phase,

said receiver having,

a multiple differential phase detected signal output unit which calculates phase differences between a received signal and received signals of 1, 2, ..., N (Where N is an integer greater than 2) symbols before so as to output the calculated results as 1, 2, ..., N symbol differential phase detected signals;

a soft decision demodulated data estimating unit which estimates a transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and Viterbi algorithm, and estimates soft decision demodulated data according to the estimated transmitted differential phase sequence and survival path metric that transit into each state on the trellis diagram; and

a second interleaving unit which interleaves the soft decision demodulated data according to a predetermined algorithm; and

a decoding unit which decodes the original transmitted data based on the soft decision demodulated data after the interleaving.

15. A communication system comprising a transmitter for

transmitting a data and a receiver for receiving the data,  
wherein

said transmitter having,

a convolutional coding unit which performs convolutional  
5 encodes the transmitted of the data;

a converting unit which converts the convolutional-coded  
data into a transmission differential phase;

a differential coding unit which differential encodes  
the transmission differential phase and maps the differential  
10 encoded data to the signal phases; and

a transmission signal generation/output unit which  
generates/outputs a differential phase modulated signal based  
on the transmission signal phase,

said receiver having,

15 a multiple differential phase detected signal output  
unit which calculates phase differences between a received  
signal and received signals of 1, 2, ..., N (Where N is an integer  
greater than 2) symbols before so as to output the calculated  
results as 1, 2, ..., N symbol differential phase detected  
20 signals;

a power detection unit which detects power of the received  
signal;

a soft decision demodulated data estimating unit which  
estimates transmitted differential phase sequence according  
25 to the 1, 2, ..., N symbol differential phase detected signals

using a trellis diagram representing transitions of differential phase states of transmitted signals and Viterbi algorithm, and estimates soft decision demodulated data according to the estimated transmitted differential phase sequence, survival path metric that transit into each state  
5 on the trellis diagram and the power; and

a decoding unit which decodes the original transmitted data based on the soft decision demodulated data.

10 16. A communication system comprising a transmitter for transmitting a data and a receiver for receiving the data, wherein

said transmitter having,

a convolutional coding unit which convolutional encodes  
15 the transmitted data;

a first interleaving unit which interleaves an order of the convolutional-coded data according to a predetermined algorithm;

a converting unit which converts the interleaved data  
20 into a transmission differential phase;

a differential coding unit which differential encodes the transmission differential phase and maps the differential encoded data to the signal phases; and

a transmission signal generation/output unit which  
25 generates/outputs a differential phase modulated signal based

on the transmission signal phase,

said receiver having,

a multiple differential phase detected signal output unit which calculates phase differences between a received signal and received signals of 1, 2, ..., N (Where N is an integer greater than 2) symbols before so as to output the calculated results as 1, 2, ..., N symbol differential phase detected signals;

10 a power detection unit which detects power of the received signal;

a soft decision demodulated data estimating unit which estimates transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and Viterbi algorithm, and estimates soft decision demodulated data according to the estimated transmitted differential phase sequence, survival path metric that transit into each state on the trellis diagram and the power; and

20 a second interleaving unit which interleaves the soft decision demodulated data according to a predetermined algorithm; and

a decoding unit which decodes the original transmitted data based on the soft decision demodulated data after the interleaving.



17. A communication system comprising a transmitter for transmitting a data and a receiver for receiving the data, wherein

said transmitter having,

5 a convolutional coding unit which performs convolutional encodes the transmitted data;

a converting unit which converts the convolutional-coded data into a transmission differential phase;

10 a differential coding unit which differential encodes the transmission differential phase and maps the differential encoded data to the signal phases; and

a transmission signal generation/output unit which generates/outputs a differential phase modulated signal based on the transmission signal phase,

15 said receiver having,

a multiple differential phase detected signal output unit which calculates phase differences between a received signal and received signals of 1, 2, ..., N (Where N is an integer greater than 2) symbols before so as to output the calculated  
20 results as 1, 2, ..., N symbol differential phase detected signals;

a power detection unit which detects power of the received signal;

25 a  $\rho$ -multiplying unit which multiplies the power by  $\rho$ ;  
a soft decision demodulated data estimating unit which

estimates transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and Viterbi  
5 algorithm, and estimates soft decision demodulated data according to the estimated transmitted differential phase sequence, survival path metric that transit into each state on the trellis diagram and the  $\rho$ -multiplied value of the power; and

10 a decoding unit which decodes the original transmitted data based on the soft decision demodulated data.

18. A communication system comprising a transmitter for transmitting a data and a receiver for receiving the data,

15 wherein

said transmitter having,

a convolutional coding unit which convolutional encodes the transmitted data;

a first interleaving unit which interleaves an order  
20 of the convolutional-coded data according to a predetermined algorithm;

a converting unit which converts the interleaved data into a transmission differential phase;

a differential coding unit which differential encodes  
25 the transmission differential phase and maps the differential

encoded data to the signal phases; and

a transmission signal generation/output unit which generates/outputs a differential phase modulated signal based on the transmission signal phase,

5 said receiver having,

a multiple differential phase detected signal output unit which calculates phase differences between a received signal and received signals of 1, 2, ..., N (Where N is an integer greater than 2) symbols before so as to output the calculated results as 1, 2, ..., N symbol differential phase detected signals;

a power detection unit which detects power of the received signal;

a  $\rho$ -multiplying unit which multiplies the power by  $\rho$ ;

15 a soft decision demodulated data estimating unit which estimates transmitted differential phase sequence according to the 1, 2, ..., N symbol differential phase detected signals using a trellis diagram representing transitions of differential phase states of transmitted signals and Viterbi  
20 algorithm, and estimates soft decision demodulated data according to the estimated transmitted differential phase sequence, survival path metric that transit into each state on the trellis diagram and the  $\rho$ -multiplied value of the power; and

25 a second interleaving unit which interleaves the soft

decision demodulated data according to a predetermined algorithm; and

a decoding unit which decodes the original transmitted data based on the soft decision demodulated data after the  
5 interleaving.